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PACKAGING PERFORMANCE TESTING OF A 55-GALLON DRUM CONTAINING EIGHT 1-GALLON RECTANGULAR PLASTIC BOTTLES – PACKING GROUP I

ALL TRANSPORTATION MODES

Date: April 27, 2004

AFPTEF PROJECT NUMBER: 04-P-101
POP TEST ID NUMBER: DODPOPHM/USA/DOD/AF69/DLA-D027

Part 1.

A. Title: PACKAGING PERFORMANCE TESTING OF A 55-GALLON DRUM CONTAINING EIGHT 1-GALLON RECTANGULAR PLASTIC BOTTLES – PACKING GROUP I

Report Number: DLA-D027
AFPTEF Project Number: 04-P-101
Manhours: 40

Report Type: **FINAL**

B.
TEST REPORT APPLICABILITY STATEMENTS see section 2E.

Report Prepared by:

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Testing Completion Date: 26 April 04

Approved for Publication and Dated: 27 April 04

Responsible Individual: Robbin L. Miller

Performing Activity: AF Packaging Technology and Engineering Facility
AFMC LSO/LOP
5215 Thurlow St
WPAFB OH 45433-5540

Specific Authority: Distribution Statement F. Further dissemination only as directed by AFMC LSO/LOP or higher DoD authority.

Requesting Organization: Defense Distribution Center
DDC-J-3/J-4-0
ATTN: POP Team
2001 Mission Drive
New Cumberland PA 17070

Part 2. Data Sheet

A. Exterior Shipping Container

UN Type: Drum, steel, removable head, 55 gallon
UN Code: 1A2
NSN: 8110-00-030-7780
Specification Number(s): N/A
Container Manufacturer: Skolnik Industries, Chicago IL. [Myer Container Corp., supplier.]
Date of Manufacture: Unknown (GSA advice code "2G" – newest stock, from DOD Emall)
Material: Steel
Container Dimensions: 22-7/16 in. x 33-5/16 in. ID
Closure (Type/Method): Attached foam gasket on flat lid, locking ring, bolt, nut.
Closure Specification Number(s): N/A.
Reinforcement (Type/Method): N/A.
Reinforcement Specification Number(s): N/A.
Absorbent Material Description: Vermiculite, Fine Grain, Palmetto Vermiculite Company, Incorporated, Grade C-3; Hazmatpac A-900, HAZMATPAC Inc.; Absorbent GP, Absorption Corporation.
Additional Description: N/R

B. Inner Packaging of Combination Packaging

Type: Natural, White or Fluorinated HDPE, Rectangular Jug (Bottle) with handle
NSN: N/A
Manufacturer/Distributor: Freund Container, Inc.
Date of Manufacture: N/R
Manufacturer's Number(s): 31127, 31128, or 31128F
Capacity: 1 gallon (4 liter)
Dimensions: 7 in. x 4 in. x 12 in.
Closure (Method/Type): Screw cap (plastic), I.D. 1.5 in; cap size 38/400
Secondary Closure (Method/Type): One strip of reinforced tape (as above) wrapped a minimum of 1-½ times around and overlapping the cap base and the bottle neck (Figure 1)
Additional Description: Inner packaging of tested item (see photos, Figures 1 – 4, and drawing).

1. Line the drum with a 4-mil low density polyethylene bag, size 38 in. x 62 in., minimum thickness and dimensions (6-mil LDPE bags, 38 in. x 63 in., sold by Hazmatpac may also be used).

2. Place 3 inches of tightly compressed absorbent in bottom of drum. Place 4 bottles on the absorbent layer, centered and evenly spaced in a pinwheel pattern (see Figure 2); each bottle cap should be 6 inches from the drum side, and each bottle should be approximately 8 inches apart, measured from cap center to cap center. Fill all open space with absorbent until bottle tops are reached, tightly compressing the absorbent every 3 inches. Cover with 3 inches of tightly packed absorbent. Place 4 bottles on this layer of absorbent as with the first; shift the pattern by 90 degrees so that the weight of each bottle in the second layer will be supported by 2 bottles of the bottom layer (see drawing). Fill around the bottles with absorbent as with the first layer. Fill to top of drum with tightly compressed absorbent. **NOTE: The quantity of absorbent used does meet the requirements of AFMAN 24-204(I), Atch 20. This packaging is intended for transportation by Military Aircraft.**

3. Shake or press down and firmly compress, and add absorbent if necessary to make a tight pack within the outer container.

4. Twist bag and tape closed with fiber reinforced tape (Figure 3).

5. Close drum using locking ring, bolt and nut to a maximum gap between the ring ends of 0.25 in., and tighten the bolt using the locking nut (Figure 4). **Note: Insert bolt through unthreaded lug first, thread the locking nut onto the bolt, then thread the bolt through the threaded lug. Locking nut must be on the bolt between the ring lugs, and tightened against the unthreaded lug to a minimum torque of 55 ft lb.**

C. Actual Product: Not Used
NSN: NA
Specification: Unknown
UN/DOT/IMO/IATA Proper Shipping Name: Unknown
United Nations Code Number: Unknown
United Nations Packing Group: I
UN Hazard Class: Unknown **DOT Hazard Class:** Unknown
IMO Hazard Class: Unknown **IATA Hazard Class:** Unknown
Physical State: LIQUID
Amount per outer container: Eight 1-gallon bottles [7.0 kg (15.4 lb) each, calculated from specific gravity]
Density/Specific Gravity: 1.8
Drop Height: 1.8 meters (71 in.)
Minimum Stacking Weight/Force Required: 360 kg (793 lb), based on Hazmatpac A900
Additional Description: N/A
Vapor Pressure (liquids only) at 50°C: Unknown

D. Test Product: Used
Name: Propylene glycol/water with sand mixture
Physical State: LIQUID
Amount per outer container: Eight 1-gallon bottles [7.0 kg (15.4 lb) each]
Gross Weight (packaged with vermiculite): 110 kg (242 lb)
Gross Weight (packaged with Hazmatpac A900): 148 kg (326 lb)
Gross Weight (packaged with Absorbent GP): 104 kg (229 lb)
Density/Specific Gravity: 1
Drop Height: 1.8 meters (71 in.)
Minimum Stacking Weight/Force Required: 360 kg (793 lb), based on Hazmatpac A900
Additional Description: N/A

E. Test Applicability- See test results in Part 6.

(1) Tests documented herein are design qualification. It is the responsibility of the government shipper/certifier to fully verify design compliance and packaging material quality.

(2) Drop testing performed herein was tested in accordance with DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This joint DoD policy document allows packaging to be drop tested more than once provided the packaging continues to pass the 49CFR 178.603 requirements. Questions or clarification about this policy can be sought from the respective preparing activities of the regulation.

(3) DoD contractor use of this test report or its resultant certifying mark only with the permission of the testing activity AND as specified in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A.

(4) Pass/fail conclusions were based on the particular specimens, both inner and outer containers, and quantities of each submitted for test. Extrapolation to other manufacturers, applications, commodities, inner containers, container sizes, or lesser internal quantities is the responsibility of the packaging design agency or applicable higher headquarters and the limitations documented in 49CFR. Extrapolation of test results based on lesser than minimum UN/DOT required test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

(5) Reference to specification materials has been made based on one of the following methods: supplied by AFPTEF, provided by the requester, markings printed on, attached to or embossed on the packaging.

(6) Testing performed in accordance with 49CFR 170-180, except as documented in this report.

(7) Performance testing was undertaken and completed at the request of an agency responsible for management of the dangerous good(s). The completion of successful UN/DOT testing does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

(8) The DOT performance tests are intended to evaluate the performance of the entire packaging configuration's ability to prevent the release of contents during conditions normally incident to transportation. The criteria used to evaluate container system performance are whether the contents of the packaging are retained intact. The successful completion of the recommended tests does not ensure undamaged delivery.

(9) Tests performed and documented, herein, in no way verify Government supplier's operations (included but not limited to: internal procedures, suppliers, or manufacturing processes) comply with the DOT's or international's regulations. The testing facility has no knowledge and assumes no knowledge, that specific material testing requirements (i.e. plastics - only allowed to use regrind from the same operation; specific vendor plastic formulations including quantity of carbon black, ultra-violet inhibitors or pigments, or production run's individual leakproofness tests) are or were performed by the manufacturer(s) listed herein, unless otherwise noted in the report.

Part 3. Introduction.

Brief description of why specific tests were performed and rationale for the test product selected (if applicable).

Packing Group I testing was requested on the above stated configuration. For lesser volumes, variations to testing requirements can be found in 49 CFR, part 178.601(g). The tested configuration is intended for all transportation modes.

Each packaging was subjected to appropriate drop and vibration testing as prescribed by ASTM D4919. These tests are designed to simulate the shock and vibration a package configuration may encounter during conditions normally incident to transportation. The order of testing was drop test followed by the vibration test; the stacking and hydrostatic pressure (to 250 kPa) tests were performed on outer containers not otherwise used in testing. Manufacturer leak and hydrostatic (to 100 kPa) results were accepted (Myers Container Corp. test date 2 March 04).

This configuration was tested using vermiculite, Absorbent GP and Hazmatpac A900. The configuration met test requirements with all three, therefore all three absorbents may be used provided the maximum gross weight for each (above) is not exceeded and they are not incompatible with the substance(s) in the inner packagings.

The use of one sample packaging configuration for multiple tests and drops is DoD policy as stated in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This option was exercised in this test as noted in Part 6.

Part 4. Tests Required/Performed (as applicable).
NOTE: Packagings fabricated from fiberboard, paperboard, or paper, including composite containers with outer fiberboard containers, should be conditioned for a minimum 24 hours prior to any testing. Standard conditions **23 ± 3°C (73 ± 4°F)** and **50 ± 2%** relative humidity apply.

A. Leakproofness test. 3 outer containers each individually tested for 5 minutes (30 minutes for plastic containers),previously performed by manufacturer.

B. Hydrostatic Pressure Test. 3 outer containers each individually tested for 5 minutes at 250 kPa (36 psi), previously tested by the manufacturer to 100 kPa (15 psi).

C. Stacking Test. One test per outer container, 3 containers required. Compression by a top load is calculated to simulate a stack height of 3 meters, maintained for 24 hours. **NOTE:** If only one configuration sample is tested, test duration shall be 72 hours.

Static weight: Apply the calculated weights using a constant load evenly over the entire container.

$$M = \frac{m\,(3000-h)}{h}$$

*where: m = container's gross mass (as shipped) in kilograms = outer container + absorbent fill +[number of inner containers * specific gravity of lading * volume of inner container * 3.8(mass of water in kg) * 0.98(min. filling of inner container)] =**148 kg***

*h = container's height in millimeters = **873.13 mm** (effective height for container in stack)*

*M = constant minimum load mass in kilograms = **360 kg***

or:
$$W = \frac{w\,(118-h)}{h}$$

where: w = container's gross mass (as shipped) in pounds = outer container + absorbent fill +[number of inner container s specific gravity of lading * volume of inner container * 8.3(mass of water in lb) * 0.98(min. filling of inner container]= **326 lb** (highest sample weight)*

*h = container's height in inches = **34.38 in.** (effective height for container in stack)*

*W = constant minimum load weight in pounds = **793 lb***

NOTE: Where the contents of the test sample are non-dangerous liquids with relative density different from that of the liquid to be transported, the force shall be calculated in relation to the latter.

Information - This test assumes similar weight containers stacked on top of the test sample. This may or may not be a valid assumption. This calculation also only provides a minimum weight. Consideration should be given to what will actually be experienced in the transportation cycle.

D. Drop Test. 6 drops in order: 3 drops diagonally on the chime, 3 drops on the weakest part not tested by the first drop (closure and/or welded longitudinal seam of the drum body). Plastic packagings and combination packagings containing plastic inner containers shall be conditioned prior to testing until the containers and contents are at -18ºC (0ºF). The drop height shall be appropriate for the packaging group of the commodity. The container shall strike a target which shall be a rigid, non-resilient, flat, and horizontal surface. The center of gravity shall be vertically over the point of impact. **NOTE:** All drops may be made on only one sample. If the sample fails after drops 2 through 6, it may be replaced by another sample identically loaded. This option was used as noted in Part 3.

1. Solids and liquids, if the test is performed with the actual contents to be carried, or with another substance having essentially the same characteristics, or for liquids if the test is performed with water and the intended contents has density less than 1.2 g/cm^3 (specific gravity less than 1.2) the drop height shall be:

Packing Group	Drop Height
I	**1.8m** (70.9 in.)
II	**1.2m** (47.2 in.)
III	**0.8m** (31.5 in.)

2. Where the test sample doesn't contain the intended contents and its specific gravity is greater than 1.2, then obtain the required drop height in meters by calculating the following with product density (d):

Packing Group	Drop Height
I	**(d) x 1.5m** ((d) x 59.1 in.)
II	**(d) x 1.0m** ((d) x 39.4 in.)
III	**(d) x 0.67m** ((d) x 26.4 in.)

Round the drop height up to the first decimal.

E. Vibration Test (domestic requirement). One test is performed per container, total of three test specimens. The test shall be performed for 1 hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material approximately **0.2 cm** (1/16 in.) thickness can be passed between the bottom of the package and the platform. The vibrating platform shall have a vertical double-amplitude (peak-to-peak) displacement of **2.54 cm** (1 in.). Perform tests in accordance to 49CFR 173 Subpart B, Appendix C and 49 CFR 178. **NOTE:** If only one configuration sample is tested, test duration shall be 3 hours.

F. Fiberboard Water Resistance (Cobb) Test. N/A

Part 5. Criteria for Passing Tests.

A. Leakproofness Test. There must be no leakage of air from the packaging.

B. Hydrostatic Pressure Test. Any leakage is cause for rejection.

C. Stacking Test.
No test sample shall leak. Composite and combination containers shall not exhibit leakage of the filling substance from the inner receptacle or container. No test sample shall show deterioration which adversely affects transportation safety or show any distortion liable to reduce its strength, cause stacking instability, or cause damage to internal container components likely to reduce transportation safety.

D. Drop Test.
Each packaging containing liquids shall be leakproof when internal and external pressures are equalized. Composite and combination containers shall not exhibit damage to the outer packaging likely to adversely affect transportation. In addition, the inner packaging shall not leak into the filling substance or lading.

E. Vibration Test.
No rupture or leakage from any of the packages. No test specimen shall show any deterioration which could adversely affect transportation safety, result in possible discharge of contents or reduce packaging strength.

F. Fiberboard Water Resistance Test. N/A

Part 6. Discussion and Test results.
Narrative description of test results, including any rationale for variations. For each packaging to pass, all applicable tests must be performed and pass criteria listed herein.

A. Leakproofness Test. Manufacturer test results accepted. See attached Myers Container Corp. UN Test Summary.

B. Hydrostatic Pressure Test.
Manufacturer test results for 100 kPa accepted. A hydrostatic test at 250 kPa was attempted, however the drum began to leak at 124 kPa and the test was discontinued. See Figure 5 and attached Myers Container Corp. UN Test Summary.

C. Drop Test. Pass
Test was conducted at ambient conditions. All packagings (and contents) were conditioned to -18ºC (0ºF) immediately prior to testing. Each packaging was dropped 1.8 meters to strike the chime diagonally 3 times; it was then dropped diagonally onto the closing ring two times with each impact at a different point near the closing bolt and dropped one time on its side to impact the welded seam. 2 bottles packaged in vermiculite had a very tiny amount of seepage under the tape wrapping the cap, which was not visible until the bottles had been removed from the drum; there was no evidence however of leakage or spillage from those or any other bottles into the filling substances of any of the drums (see Part 5, C). See Figure 6.

D. Stacking Test. Pass
Duration: 72 hours at standard conditions: 23ºC, 50% RH. One empty closed outer container was stacked with 1250 lb for 72 hours. There was no damage to the drum which could result in damage to the inner items, no crushing, nor stack instability. No other adverse results were noted. See Figure 7.

E. Vibration Test. Pass
Duration: 3 hours at ambient. The same packagings used in the drop tests were also used for the vibration test. Each packaging was tested on an electro-hydraulic vibration table which was set at 1-inch vertical double amplitude (peak-to-peak) displacement, at a frequency such that the packaging was raised from the platform. The distance was measured using a 1/16-inch feeler gage. At approximately 4.36 Hz the feeler gage could be passed between the bottom of the package and the table surface. There was no additional damage to the outer container caused by the vibration and no leakage from the inner containers. This test procedure duration of 3 hours with one container exceeds the 49 CFR requirements. See Figure 8.

F. Water Resistance (Cobb) Test. N/A

Part 7. Performance Marking on Container:

The container specified herein passes the DoT and international regulatory requirements to the extent tested. Equivalent DoD built or grandfathered containers MAY also qualify for the following marking as directed by DoD policy documents.

u
n **1A2/X148/S/04/USA/DOD**

Part 8. References
- **A.** 49CFR 170-180
- **B.** DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55A/MCO 4030.40A - Packaging of Hazardous Materials
- **C.** ISO 535/TAPPI T 441/ASTM 3285 - Determination of Water Absorption of Paper and Board (Cobb Method)
- **D.** ISO 3574 - Cold-reduced carbon steel sheet of commercial and drawing quantities.
- **E.** ASTM D999 - Methods for Vibration Testing of Shipping Containers.

Part 9. Distribution List

Commander
Defense Logistics Agency
DDC-J-3/J-4-0
ATTN: POP Team
2001 Mission Drive
New Cumberland PA 17070

AFMC LSO/LOP
Project Folder

Figure 1. One-gallon rectangular plastic jug with taped cap.

Figure 2. Placement of four 1-gallon plastic jugs in outer container.

Figure 3. Closure of inner liner.

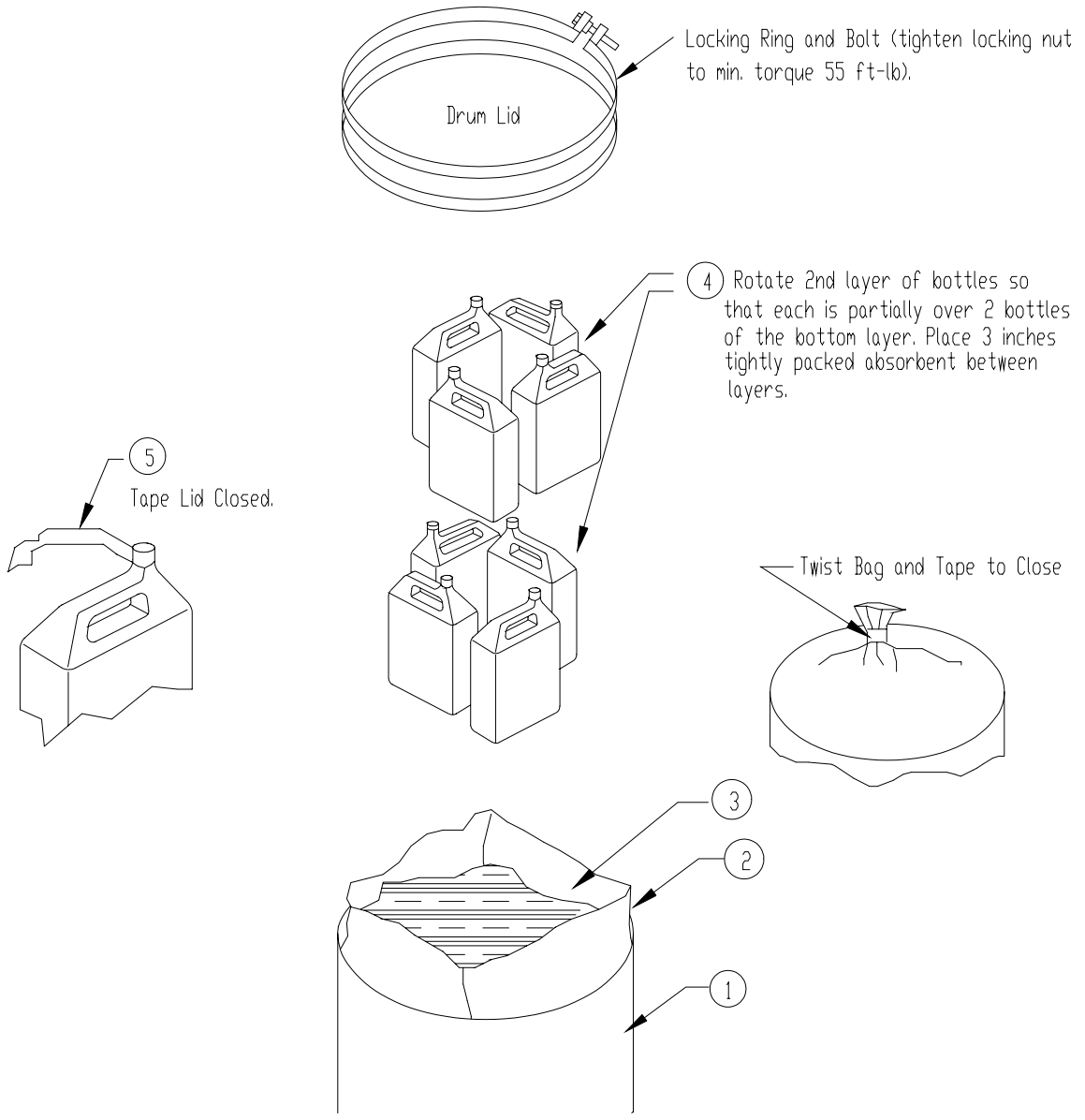
Figure 4. Closure of outer container.

Figure 5. Hydrostatic pressure test..

Figure 6. Drop test.

Figure 7. Stack test.

Figure 8. Vibration test.



Item	Qty	Description	Notes
5	A/R	Fiber Reinforced Tape	NSN 7510-00-582-4772
4	8	Inner Containers, 1 gal (4 l) HDPE Rectangular	Freund Stock Nos. 31127, 31128 or 31128F
3	A/R	Absorbent Fill	Vermiculite, Absorbent GP, Hazmatpac A900
2	1	4 or 6 mil LDPE Bag	Min. Dim. 38 in. x 63 in.
1	1	Steel Open Head Drum	NSN 8110-00-030-7780

File: DLAF029-04.DWG	AFPTEF Air Force Packaging Technology and Engineering Facility	Note: Follow All Instructions in TR
Dwg No: DLAF02904D		Dimensions in Inches
Engineer: SJ Evans	DATE: 12 April 04	Scale: NONE
		PAGE 1 OF 1

Myers Container Corporation
UN Testing Laboratory
900 Brookside Drive
San Pablo, CA 94806

UN Test Summary
Non-Bulk Steel Packagings

As required by 49 CFR 178

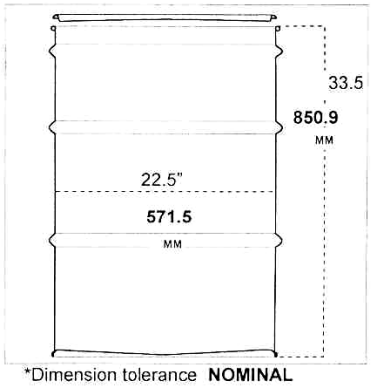
5A58
Design Number

3/2/04 *Test Date* | **Design Qualification** | **1032** *UNUM#*

Style	1A2			
Condition	NEW			
Capacity	208.2	liters	55.0	gal
Overflow	213.5	liters	56.4	gal
Tare	18.6	kg	41	lbs
Height	850.9	mm	33.5	in
Diameter	571.5	mm	22.5"	in
Steel-Head	1.2	mm		
Steel-Body	0.9	mm		
Steel-Bottom	1.2	mm		
Special Construction	Cargile curl, DOT 7-A compliant with 4-10 mil bag, UNUM 390 (History in 5558)			

End Seam	TRIPLE
Side Seam	WELDED
Swedges	3
Head Fittings	2" X 3/4"
Body Fittings	
Fitting Gasket	Poly
Covers	2 Re-enforce Ring
Gasket	EPDM
Gasket Diameter	7/16"
Ring Gage	12 GA
Closure Ring	V-BACK
Bolt Size	5/8"

55-OH



*Dimension tolerance **NOMINAL**

Drop Test - Liquid (§178.603)

Six samples are filled to >= 98% capacity with water. Each sample is dropped from the indicated height onto a solid surface using various attitudes. Drums are vented after each drop. Weakest Part: Tight-heads, second drop is flat on side seam. Open-heads second drop diagonal on head.

1.5 **Meters**

Sample	Attitude	Result
1	Chime Diagonal	No Leak
2	Chime Diagonal	No Leak
3	Chime Diagonal	No Leak
4	Weakest Part *	No Leak
5	Weakest Part *	No Leak
6	Weakest Part *	No Leak

Leakproofness Test - Liquid (§178.604)

Three samples, with all closures in place, are subjected to the following internal pressure and restrained under water for a minimum of five minutes.

20 **kPa**

Sample	Result
1	No Leak
2	No Leak
3	No Leak

Hydrostatic Pressure Test - Liquid (§178.605)

Three samples are filled to >= 98% capacity with water and subjected to the following internal hydraulic pressure for five minutes.

100 **kPa**

Sample	Result
1	No Leak
2	No Leak
3	No Leak

Stacking Test - Liquid (§178.606)

Three samples are filled to >= 98% capacity with water and subjected to a force applied to the top surface of the drum for 24 hours equal to the total weight of identical packages which might be stacked on it during transport. Minimum stack height is 3 m.

1297.3 **Kilograms**

Sample	Result
1	No Deformation
2	No Deformation
3	No Deformation

Drop Test - Solid (§178.603)

Six samples are filled to 95% capacity with a small grain lading. Each sample is dropped from the indicated height onto a solid surface using various attitudes.

Packing Group I	Packing Group II	Packing Group III
1.8 Meters	1.2 Meters	.8 Meters
	415	

Gross Mass - Kilograms Indicated Above

Net Mass - Kilograms = Gross Mass less Tare Weight

Sample	Attitude	Result	Sample	Attitude	Result	Sample	Attitude	Result
1	Chime Diagonal	No Leak	1	Chime Diagonal	No Leak	1	Chime Diagonal	No Leak
2	Chime Diagonal	No Leak	2	Chime Diagonal	No Leak	2	Chime Diagonal	No Leak
3	Chime Diagonal	No Leak	3	Chime Diagonal	No Leak	3	Chime Diagonal	No Leak
4	Closure Diagonal	No Leak	4	Closure Diagonal	No Leak	4	Closure Diagonal	No Leak
5	Closure Diagonal	No Leak	5	Closure Diagonal	No Leak	5	Closure Diagonal	No Leak
6	Closure Diagonal	No Leak	6	Closure Diagonal	No Leak	6	Closure Diagonal	No Leak

Stacking Test - Solid (§178.606)

Three samples are filled to 95% capacity with a small grain lading and subjected to a force applied to the top surface of the drum for 24 hours equal to the total weight of identical packages which might be stacked on it during transport. Minimum stack height is 3 m.

1297.3 **Kilograms**

Sample	Result
1	No Deformation
2	No Deformation
3	No Deformation

Liquid Rating	Solid Rating
UN 1A2/Y1.5/100	**UN 1A2/Y415/S**

Vibration Standard - (§178.608) This packaging is capable of withstanding, without rupture or leakage, the vibration test outlined in this section.

General Requirements - (§173.24, §173.24a, §178,601) This packaging complies with the general requirements for packagings and packages.

Package Assembly Instructions - For correct package assembly see assembly instructions provided with your order, or visit our website at "www.myerscontainer.com" and click on UN Assembly Instructions.

All drums were assembled for testing as specified in the current version of the Drum Assembly Instructions

Test Type: **DESIGN QUALIFICATION**

Date: **3/2/04**

UN Testing Lab Coordinator - Dana Zanone

Document # UFORM003	Issue Date 5/23/2001	Revision # 7	Authority Sean Reynolds	Page 1 of 1